INDEPENDENT PEER REVIEW PANEL

Center for Independent Experts (CIE) Panel Review of the Joint Pacific Sardine and Hake (SaKe) acoustic-trawl surveys

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EXECUTIVE SUMMARY

Ecosystem approach concepts have been developed by the Food and Agriculture Organisation (FAO) in order to better understand the changes in population dynamics due to environmental conditions as well as to evaluate the consequences for the ecosystem of an overexploitation by the fisheries. Since the time FAO presented this approach, many works have demonstrated the interest of such approach and it is admitted nowadays that it is difficult to manage a fish stock without any information on the environment. Therefore deciding that the hake and sardine would be studied and observed during acoustic surveys extended to the whole ecosystem makes sense.

At the moment there are two rather comparable US scientific teams working on acoustic stock assessments on different target species along the west coast of North America: one team studying the hake (*Merluccius productus*), based at the Northwest Fisheries Science Center (NWFSC), in Seattle, WA, and another team studying the sardine (*Sardinops sagax*) and other coastal pelagic stocks (CPS), based at the Southwest Fisheries Science Center (SWFSC), in La Jolla, CA. Both teams use similar techniques, methods and devices for their respective surveys, and perform at least one summer survey all along the US coastline, with additional coverage in Canada through international agreements and treaties.

There is no major problem to merge the two surveys inside a single one, due to the high inter-compatibility between both methods and techniques. Therefore, SaKe should be approved and decided. In this case, and despite its higher cost, the possibility of combining systematic annual survey and biennial research and experiments with surveying is by far the best. Actually it is only possible if two research vessels are available each year for this program. It seems that this will be the case when a new R/V is available, in 2014 or 2015, according to information provided by the National Oceanic and Atmospheric Administration (NOAA).

The proposal of transforming the separate summer hake and sardine surveys into a single summer SaKe survey presents a great number of advantages compared to continuing performing separate surveys, in many aspects. Obtaining highly accurate information every two years plus a general overview in other years seems the best compromise in order to dedicate time for necessary research. Indeed some points in the methodology as well as some biological and ecological question remains and must be documented. I recommend a sampling strategy based on the use of two research vessels, where one of them would perform the same survey each year and the other one would add to the acoustic-trawl sampling during years 1, 2, 3… in order to obtain precise abundance estimate once each other year, and perform research activities and experiments during years 2, 4, 6… in order to improve the survey methods and techniques and provide additional information on the ecosystem and the other fish species that are not fully observed during the complete surveys of the other years.

Such survey design could be applied during five years, as suggested by the two centers, and an evaluation done after this period in order to produce a final decision of the SaKe methodology.

1. GENERAL OBSERVATIONS ON THE EVALUATION PROCESS

General presentation

There are two rather comparable US scientific teams working of acoustic stock assessment on different target species along the west coast of North America: one team studying the hake (*Merluccius productus*), based at the Northwest Fisheries Science Center (NWFSC), in Seattle, WA, and another team studying the sardine (*Sardinops sagax*) and other coastal pelagic stocks (CPS), based at the Southwest Fisheries Science Center (SWFSC), in La Jolla, CA.. Both teams use similar techniques, methods and devices for their respective surveys, and perform at least one summer survey all along the US coastline, with additional coverage in Canada through international agreements and treaties. In both cases the surveys are organized for providing the stock assessment programs with abundance estimates; they are not supposed to cover all the components of the ecosystem.

In 2011 the hake surveys and assessment gave unexpected results that convinced the scientists to perform an additional survey in 2012: usually, hake surveys are performed each other year (last ones being in 2009 and 2011). In order to get results on hake in 2012 they embarked in the 2012 annual CPS survey. The compatibility of the methods and protocols as well as the perspectives that such common work demonstrated encouraged the teams to propose to organize the "SaKe" (SArdine-haKE) survey i.e. a common summer survey to collect data for the two groups. Although a few, limited and expected problems occurred, the results of the first SaKe survey in 2012 were encouraging enough to suggest merging permanently the two specific surveys in a single ecosystem-based multiple species survey. After the first trial in 2013 the project was proposed for evaluation.

Personal background

My main field of expertise is in the use of acoustic methods for studying the pelagic fish populations. This general expertise covers different areas, i.e. the knowledge of acoustic methods and instruments; the calibration procedure; the survey design methods; the statistical measurements of confidence intervals for the abundance estimates; the fish behavior and its effects on the precision of the estimates and particularly the biases due to dynamic movements of the populations (e.g. migrations) and the patchiness and aggregation behaviour (requiring adaptations of the survey design); the statistical methods adapted to the particular case of both survey and distribution constraints (geostatistics); the relationships between fish population behavior and environment; and the methods for calculating abundance estimates with their confidence interval.

Description of my role in the reviewers' activities

My expertise in this review was mostly focused on four areas: the acoustic methods for evaluating abundance of fish; the survey design and the application of geostatistics for calculating variance estimates; and the effects of fish behavior on the precision of the results (error and biases). By contrast, I did not focus on the assessment methods of which I am less familiar. Moreover, I am more of an expert in the works and activities of the CPS team than those of the hake team, for three reasons: my scientific activities have always targeted small pelagics (sardine, anchovy, jack mackerel, etc.), similar to the species the CPS works on; I am familiar with the works of the SWFSC because I have been reviewer of several papers of this

team, especially those on potential habitat, and I have been CIE expert for evaluating the works on *Sardinops sagax* in the recent past; and I have worked in co-operation with Mexican colleagues (Dr Carlos Robinson, UNAM, Mexico DF) on *S. sagax* populations in Bahia Magdalena, Baja California, Mexico. Nevertheless I did not find any difficulties in studying the works of the NWFSC team, which develops standard methods of acoustic estimates. Therefore I am confident that my comments on these fields are consistent.

Comments on the NMFS review process

I have no major comments to provide on the general organization of the review process. The documents that had been delivered in time to the experts fully covered the themes and the different terms of choice (separate vs. joint surveys) were well described. I was particularly impressed by the availability of the teams and the staff of the NWFSC and SWFSC, who gave us all the information that we requested. I also appreciated the complementarities of the different experts of the group, which allowed for fruitful exchanges inside the expert panel on the different aspects of the effects of joint vs. separate surveys, especially in terms of effects on assessment, which is an area I am not familiar with.

Concerning the documents delivered to the expert panel, I regret that we did not get the conclusions of the former CIE evaluations on the acoustic methods used by the two teams that had been done a few years ago: without these documents, sometimes we had to go into too much detail on some of the technical points, or on the contrary to decide not to enter in some others although we did not get clear information, assuming that they have already been evaluated and corrected. I learned, for instance, that the geostatistical activities were evaluated formerly, and that evaluation could have helped us to better understand the choices and activities developed by the teams in this part of the research.

One last point is that it seems that some disagreements exist between the NW and SW teams. Although I have been convinced by each one separately that their goodwill is real and that they are completely open and ready to adapt to each other, I suggest a particular attention be given by the directions of the two centers on this point: it would be sad that misunderstandings between the two teams could damage this great project.

2. SUMMARY OF FINDING FOR EACH ToR

Note: I did not include in the text the references that come from the documents provided by the CIE, but only the additional material that is listed in the bibliography.

1) Review background materials and documents that detail acoustic-trawl survey design and methods, and data analysis methods and results for:

- ***a. Pacific sardine surveys;***
- ***b. Pacific hake survey;***
- ***c. Joint sardine and hake (SaKe) surveys.***

The scientists of the two centers reminded us that the acoustic methodology for these two series of surveys have already been separately reviewed by CIE expertise (I had been a reviewer for the CPS methods and techniques, as stated above) and their methods and

techniques have been approved; we decided not to enter precisely again in technical details. The acoustic methods and techniques will be considered only in their effects on merging the two survey methods.

From the literature review and after synthesizing the presentations of the scientists, the following observations could be listed:

- Some characteristics are different between hake and sardine surveys: pelagic for CPS, semi-pelagic for hake; coastal for sardine (and even more for anchovy) and offshore for hake; high concentrations in small areas for sardine, much more wide and even distributions for hake (see maps of distribution for the two species); both species are studied by day through acoustics, but hake is sampled by day (trawling) and sardine by night.
- The patchiness and distribution characteristics of sardines encouraged the SW team to develop an important research on the potential habitat of sardines, which is a remarkable instrument for defining the survey area. This has not been done by the NW team on hake, of which the distribution seems to be more predictable.
- Sardine presents a particular characteristic compared to hake: the existence of a southern independent population mostly present in Mexican waters. The "border" between the two populations, according to the potential habitat studies, is represented by the isotherm of 16.4ºC. This characteristic must be taken into consideration for the survey design in order to observe separately the two populations.
- The surveys are explicitly multispecific for sardine (results mostly on sardine, but also on jack mackerel, mackerel, anchovy), and explicitly monospecific for hake. This makes it more difficult for the transformation of a hake survey into a multispecific survey, while it does not present a major problem for the sardine surveys.
- Assessment: as far as economical weight is concerned, hake is much more important than sardine. Besides, according to the scientists conferred, the sardine stock enters in a collapsing phase, which may soon result in a lack of economic interest for sardine.
- International aspect: hake is binational, shared between the USA and Canada and surveyed jointly by the two countries each other year; sardine is trinational, with stocks in Mexico-USA in the winter and spring and USA-Canada in the summer, although only US scientists survey them: a SaKe survey could be a good opportunity to standardize the surveys of the three countries in order to provide a general overview of the whole California Current Ecosystem as far as CPS are concerned.
- By nature the CPS that is already a multispecific survey has no major technical or methodological problems to fit in a SaKe survey, contrary to the hake survey.
- The teams have slightly different centers of interest and backgrounds: the SW team is based on a strong acoustic expertise while the NW team is more centered on ecology and assessment. But both cover the full set of expertise (ecologists and assessment scientists are also present in the SW and acousticians in the NW teams).
- SaKe surveys already performed: in 2012 no comment on the compatibility of the two researches was made, mostly because it was not a real SaKe survey but a sardine survey opened to hake scientists. In 2013, which was the first SaKe survey, some potential conflicts of time allocation appeared, in several points: hydrological sampling (xBT, CTD etc.) and fish sampling, by day for hake and by night for sardine, which imposed changing the gear (and doors) every dusk and dawn.

2) ***Evaluate the historic, independent sardine and hake survey designs, methods, and analytical approaches including data preparations and statistical (e.g. geostatistical) analyses to estimate target species abundances, distributions, and biomasses, and associated uncertainties.***

Methodology.

- General method of acoustic estimates. Many parts of the methods present no difference and the methodology is the same in the following points: acoustic observation by day plus fishing operations for biological sampling; use of the same acoustic frequencies (38 kHz and 120 kHz as references and 18, 70 and 200 kHz as ancillary); same fishing strategy where fishing operation is decided according to the acoustic information, and same use of the biological data for evaluation of the biomass per age/length class; same methods for biomass abundance estimates and variance calculation (geostatistics); same sampling strategy through equidistant parallel transects roughly perpendicular to the coastline (i.e. perpendicular to the anisotropic axes); same inter-transect distances (10 nautical miles); same collection of hydrological variables by the way of CTD stations; same use of target strength values for translating the NASC into absolute biomass (weight) values; same methods for calibrating the equipment. The general acoustic methods follow the recommendations of the ICES WGFAST and those of the most important authors in this field (see Simmonds and MacLennan, 2005; Rivoirard et al, 2000; Foote et al., 1987; Reid, 2000; etc.).

- Main specific differences. The two populations are observed by day (schools for the sardine and dense layers for the hake) and fish are scattered by night and mixed with other organisms (making the echo integration by night difficult or impossible): this allows common and good acoustic estimates by day. On the contrary the differences in behavior impose different trawling strategies. Hake must be sampled by day in the layers where it is rather easily catchable and where no other species can contaminate the observation; in the case of sardines fish are not gathered in layers by day but in smaller individualized schools that are not easily catchable (high avoidance speed), so the trawl sampling must be done by night.

Survey design.

- Hake. The population is rather evenly distributed in a large layer located above given isobaths by day. This is a very favorable pattern for acoustic surveys. In this case the standard survey method is applied, such that equidistant transects perpendicular to the axis of the layer are utilized. Inter-transect distance is rather small (10 nautical miles) for such aggregation characteristics. No acoustic observation is made by night, the reason being that hake is mixed with other species and micronekton, making the results difficult to analyze. As the summer distribution of hake is located both in US and Canadian waters, each country operates its own research vessel and the survey area is split in two parts, each one surveyed by a research vessel. The common survey is performed each other year jointly by the two countries, with the coverage including part of Canadian waters. The population is assumed stable (not migrating) during the survey period (up to 90 days) and no correction is considered on this point.

- Sardine. The population is more patchy and concentrated in small areas inside the potential habitat and the survey area (in the case of summer surveys; this is slightly

different for spring surveys that are not to be considered in this review). Another characteristic is that the population is shallower than in the case of hake. Such a combination of shallow distribution and schooling usually produces biases due to blind zones close to the surface (out of reach of the vertical echo sounder) and fish avoidance. This set of characteristics makes the sampling strategy more difficult to establish. Moreover the fact that the sardine survey is also a CPS survey, adds to the difficulties. For instance, anchovies are extremely close to the shore and difficult to observe exhaustively with the standard sampling strategy. One way to overcome these points was to define a potential habitat within which the survey design is fitted; some research using multibeam sonar were developed to evaluate the possible biases such fish behavior may introduce, and particularly school avoidance and occupation of the blind zone (0 to 10 m depth). The results allowed considering the biases induced by these characteristics as small enough to be ignored. Apart from this effort on sonar observation and potential habitat design, no real care is given to this high patchiness in CPS surveys. Therefore the survey is standard, i.e. with parallel equidistant (10 nautical miles) transects, perpendicular to the coastline. The effect of potential contamination of the north (US) stock biomass by the presence of the south (Mexico) stock has been considered by comparing the results of the spring and summer surveys, and the conclusion has been that no real effect of the southern stock was visible. As in the case of the hake, it is assumed that the sardine population does not migrate during the period of the survey (also around 90 days). When the sardine stock crosses the USA-Canada border, the US survey is extended to Canadian waters. In some cases a fishing vessel is used jointly with the research vessel in order to perform fish sampling and observations in shallow waters.

Calibration and target strength. The two groups apply a similar calibration procedure using a standard calibration sphere. There is no remark to be made on these procedures, which are correct and well performed. No clear information on intercalibrations between the different vessels is presented, in the case of hake (US and Canadian R/Vs) as well as in the case of sardine (US R/V and fishing vessel). Target strengths are calculated using the standard equations developed by K. Foote, using a protocol defined by the ICES WGFAST, for a transformation of NASC to absolute biomass estimates per length (Foote et al., 1987).

Biomass estimates and confidence interval. The two teams use methods based upon the use of geostatistics (Rivoirard et al., 2000) as recommended by the ICES WGFAST[1] working group. I have no major remark in this field. Nevertheless some questions arose:

- Hake (and sardine) migration. The duration of the surveys is rather long (between 60 and 100 days) and the area observed quite extended. The two populations are known as migratory, with both species moving southward in autumn and northward in spring. The summer surveys in the two cases assume that the migration has ended at the time of the survey, which is not tested. If this is not the case, then a bias appears, either overestimating the biomass if the migration goes northward, as both surveys go from south to north, or underestimating it if the migration is southward. Although the

[1] ICES Working Group on Fisheries Acoustics Science and Technology

assumptions are realistic and corresponding biases unlikely, it could be important to test this point.

- Delimitation of distribution areas. In the case of sardine there is no major difficulty as the stock is highly concentrated in small areas; in the case of the hake, the delimitation of the distribution area has not been clearly described. It is known that for a geostatistical estimate of abundance it is necessary to define the boundaries of the distribution; in some cases these boundaries were not found and the biomass estimates was extended to arbitrary limits. This was unlikely to bias significantly the estimates, but some research would be necessary to define boundaries in a lesser arbitrary way. Works on potential habitat should be encouraged, as well as the use of information from the fishery (use of acoustic data collected aboard fishing vessels; see Karp, 2007).

- Correction of anisotropy. No correction was made (or at least was detailed to the panel) in the case of sardine. This is understandable, because of the patchiness distribution of the stock. In the case of hake, a sophisticated method for taking into consideration the anisotropy is applied. I am not sure whether this completely corrects the anisotropy, and even if it is necessary. Nevertheless a CIE evaluation has been done on this point and recommendation should be found in the ad hoc expert panel report. Some additional research should be done on this point. The characteristics of the distribution of hake are such that anisotropy can be an issue.

Biological sampling. Both surveys perform biological samples using midwater trawl.

- Hake. The sampling is performed during the collection of acoustic data by day; in this case the transect is interrupted in order to sample any noticeable detection. Then the data are processed and analyzed in a completely standard way.

- Sardine. Contrarily to the hake survey and due to different distribution characteristics, the biological sampling (with a gear different from the one used for hake) is conducted at night in order to take advantage of a lower reaction of fish to the gear (sardines are dispersed and passive). In this case, the interesting concentrations are noted by day and the vessel comes back to the point by night when the same vessel is used; alternatively, the fishing vessel is informed and goes to the point for a night catch. This last method has the advantage of avoiding any interruption of the acoustic sampling, and the inconvenience of requiring the assumption that what is sampled by night is effectively what was recorded by the echosounder by day, i.e. 12 hours prior. Nevertheless the assumption is probably correct and the method is acceptable. Then the samples are processed in the same way as in the case of hake, following the recommendations of the ICES WGFAST.

In conclusion, as expressed above, there is no major incompatibility between the two biomass estimates and survey strategies between the two groups.

3). Evaluate the current joint SaKe survey design, methods, and analytical approaches including data preparations and statistical (e.g. geostatistical) analyses to estimate target species abundances, distributions, and biomasses, and associated uncertainties.

Thanks to this methodological compatibility between the survey methods, the two surveys (hake and CPS) can be rather easily merged. However, this requires some adjustments. The experience of the joint survey in 2012 and the first SaKe survey in 2013 allow a good analysis of these requirements and a series of recommendations.

The biological sampling of hake reduces the time devoted to survey for the sardine by day, and the night catch for sardine reduces the time devoted to hydrological and other biological studies for the hake by night. In both cases the integration of the two surveys results in reducing the overall time that can be allocated to the research program of a single species survey. The other point concerns the fact that each species requires a different gear for sampling. This requires that the crew has to change the gear each dusk and dawn. One benefit is that there is no need to change gear at every moment, as sardine are caught only by night and hake only by day.

Differences in aggregation behavior. This point is important and has not been clearly detailed in the documents and during the discussions. The two species present very different aggregation characteristics that could suggest the use of different sampling strategies. Nevertheless the works developed during the individual surveys and the joint surveys seem to indicate that there is no major effect when using a common strategy. My feeling is that CPS surveys would ideally require some adapted sampling: inter-transect distance of 10 NM is the largest acceptable for CPS in those areas where fish is observed, while it could be much wider in the areas where fish is not observed. Such an adaptive strategy is not easy to perform and not always statistically acceptable. Therefore it is easy to understand why the inter-transect distance of 10 NM is used all over the surveyed area for sardine. But such narrow inter-transect distance is certainly oversampling the hake. In case the sardine survey would be a real CPS survey (including anchovy and jack mackerel), the sampling design would be extremely difficult to draw: jack mackerel is widely distributed especially offshore, while the anchovy distribution is limited to a few shallow coastal areas (not easy to survey with a large research vessel). It seems probable that for a correct sampling of all the pelagic species (1) multiple vessel surveys would be required, and (2) indirect methods of habitat definition for the main target species would be needed, allowing for meaningful extrapolations.

Annual versus biennial surveys. There is a need for annual surveys in the case of sardine, due to the high variability of recruitment and the short lifespan of sardines; this is less critical in the case of hake. The experience shows that a biennial survey is usually sufficient for a correct assessment, although in some occasion (e.g. 2011) unexpected results made necessary the organization of an additional survey (e.g. the incorporation of “hake scientists” in a CPS survey in 2012).

Differences in “scientific culture” of the teams. Although this is not, strictly speaking, related to survey design, the fact that the two teams have developed different approaches on their respective survey programs will require some adaptations and habituation of each other before to become fully operative. To simplify this, we could say that the SW team is

specialized in fisheries acoustics and uses sardine to develop its research in acoustics while the NW team is specialized in fisheries ecology and uses acoustics to develop its knowledge on the ecology of hake. This is likely to produce some difficulties at the beginning, but there is no doubt that after a few surveys they will enrich each other with their respective expertise. The compatibility of the two methods and teams once completed will certainly produce a remarkable group of research on ecosystem approach of pelagic fish and development of adapted acoustic instruments and methods. If we consider that teams of Canada in the north and Mexico in the south are connected to this team, the perspectives opened by the combination of NW and SW teams for the monitoring and understanding of the California Current ecology and the assessment of pelagic fish populations are exceptional.

4) **Evaluate the tradeoffs, in terms of costs, benefits, and consequences, of transitioning from independent surveys to a joint sardine-hake survey, particularly regarding its potential to provide population trend information to each of the assessments**.

Generally speaking, the balance of merging the two NW and SW surveys is highly beneficial. In detail, the costs and benefits are as follows:

Costs. The reasons for the costs are related to the following points. (1) We may imagine that the necessary homogenization of methods and instruments will require the acquisition of some instruments, although we did not get detailed information on this point. It is likely that the use of multibeam sonar observation methods that have been developed in the SWFSC will have to be generalized and might impose the purchase of such instruments by the NWFSC if this Center does not already possess them. It is also possible that some more frequent travel by scientists from NW to SW and vice versa will be necessary. (2) Another potential source of cost increase would be the result of adaptation of the surveys to other populations than sardine and hake (mostly coastal pelagic species, such as anchovies and species of large distribution, jack mackerel, and micronekton). Indeed if the common survey becomes an ecosystem monitoring survey, a wider sampling strategy will be necessary and such activity, especially for the biological sampling of coastal pelagics, and it will require hired vessels. Nevertheless, due to the fact that the general methodology is already common to the two centers, the reasons for cost increasing are very few.

Benefits. These are much more important. The first one is the fact that a single vessel will provide information for the two principal species (sardine and hake), likely reducing costs by reducing the time at sea. Actually this particular case is only true if a single vessel is used. The panel received the information that a new research vessel would be available for research and acoustic surveys very soon; in this case, the benefit would be due to the fact that using the same number of days-at-sea with two separate surveys that are performed simultaneously by two vessels would allow allocating time to various scientific activities related to the stock assessment (e.g. oversampling in particular areas, scientific experiments to evaluate biases, reducing variance, use of new acoustic devices, etc.), and not only surveys.

Other points. Beside the financial costs and benefits, there are some other consequences that are listed below.

We have seen that the two surveys require some specific work (for instance, the choice of different gears for biological sampling; the need of different sampling efforts due to different fish distributions; the possible need for hired fishing vessels for biological sampling in areas out of reach of the R/V, etc.). This will require some extra time, which means that a common survey will be slightly longer than each single survey. In case of the use of a single R/V, the total time will be in any case much smaller than the sum of the two specific surveys; in case of the use of two R/Vs, the time would be identical or slightly smaller than the sum of two specific surveys.

A point that would have to be tested is that of the general sampling effort. I have shown that sardines and hakes are distributed differently and that ideally a different sampling effort should be devoted to each of the two species. Curiously the two teams have selected the same sampling effort (i.e. with 10 NM inter-transect distances), which is probably far too high for the hake. Considering that the number of days-at-sea will become an issue, some specific research devoted to the actual need of sampling effort for each species that would provide biomass estimates with an agreeable variance should be performed. In the probable case that sardine is collapsing, as suggested by the works of the SW team, adaptive sampling effort in the north part of the survey area could be considered (absence of sardine). The micronekton (krill, myctophids, etc.) does not present a particular constraint in the survey as it is usually widely and evenly distributed, which would require even less sampling effort than the hake.

In conclusion, the common survey would be highly beneficial for the Centers and for the scientists. In their case the reasons would not be related to cost but to scientific exchanges: the two teams have developed excellence in slightly different domains and sharing their respective experience would be of great interest for both.

5) **Evaluate the potential of the SaKe survey design and analysis, or an alternative, to evaluate the status and trends of hake, as managed by the International Hake Treaty, the southern stock of sardine, and other stocks in the Pacific Fisheries Management Council's Coastal Pelagic Fisheries Management Plan (CPS-FMP) including: northern anchovy (northern and central stocks), Pacific mackerel, jack mackerel, market squid, and krill**.

There are two reasons for transitioning from independent surveys to a joint sardine-hake survey. The first one is strictly economic and it is clear that from this point of view there is a real benefit to go from two separate surveys to a single common one. The second is scientific, and the objective in this case is to go from a single species assessment to an ecosystem approach of the fish population dynamics. This point is worth some analysis before to consider the question of evaluating the status and trends of hake as managed by the International Halibut Treaty, etc.

Ecosystem approach concepts have been developed by Food and Agriculture Organisation (FAO) (Garcia et al., 2005; Garcia, 2007) in order to better understand the changes in population dynamics due to environmental conditions as well as to evaluate the consequences for the ecosystem of an overexploitation of some particular species by the fisheries. Since 2005, many works have demonstrated the importance of such approach and it is increasingly accepted that it is difficult to manage a fish stock without any information on the environment.

Therefore deciding that the hake and sardine would be studied and observed during acoustic surveys extended to the whole ecosystem makes sense. Indeed, acoustic methods are the only ones that are able to provide simultaneous and synchronic information over the same sampling point on all the levels of the ecosystem structure, from plankton to the top predators, and since 2010 even the 3-D structure of the water mass (Bertrand et al., 2010). Interactions between the ecosystem and the fish population can be studied. Under these conditions it is clear that moving towards an ecosystem approach to fisheries (EAF) is possible and indispensable. This reason is in my mind the most important argument in favor of the transition from single stock surveys to a common ecosystem survey.

Hake. The SaKe survey must be analyzed within the scope of the International Hake Treaty, which specifies the need to evaluate the status and trends of hake.

For hake, no real drawback can be identified. The sardine fish sampling by trawling is done by night, i.e. during a period where there is no acoustic survey; and the spatial distribution of hake allows a lower sampling effort than for sardine. The two areas of the two species are overlapping, which means that there is no loss of time due to sampling in a no-hake area. There is need for adaptation (e.g. hydrological sampling that are different in the two types of survey and must be homogenized), but this is not a major issue.

The question of selecting an annual of biennial survey sampling is important. The experience of the last years shows that “surprises” may happen and unexpected results occur. Moreover, an EAF requires you to follow frequently the global ecosystem, especially in areas such as the EBOE (Eastern Boundary Oceanic ecosystems, i.e. California, Canarias, Humboldt, Benguela systems), where strong changes from one year to them other occur frequently (El Niño events) that are likely to change the characteristics of the ecosystems and the dimensions of the populations. Therefore it seems that in an EAF framework an annual survey should be preferred to surveys each other year. One possibility of fulfilling the International Halibut Treaty and the EAF needs would be to organize an international survey year 1, 3, 5… and another NOAA survey year 2, 4, 6… even if this survey does not cover Canadian waters.

Sardine and CPS. As stated in the paragraph on hake, the changes that could be done to fit the SaKe to CPS surveys are more numerous than those for the hake. The first one concerns the acoustic sampling design that may not be fully adapted for anchovy and jack mackerel. For anchovy a denser sampling (smaller inter-transect distances) in the limited concentration areas could be necessary for obtaining a correct abundance estimate. For jack mackerel it is unlikely that the survey could cover the full distribution area, therefore no real solution exists except the use of data from fishing vessels exploring and exploiting this species, and work on potential habitat. Another point is the fact that sardines have to be sampled by midwater trawl by night, which overlaps with the time devoted for the hake survey. Here too, hiring a fishing vessel is likely to be necessary. An additional point is that the inter-transect distance for sardine (10 NM) seems more adapted than the same distance for hake. This means that for a common survey, 10 NM will be necessary. Although this has no effect on hake surveys, it creates a survey duration of at least 80-90 days for a complete coverage of the US-Canada areas. Finally the turnover of sardine is faster than for hake, and an annual survey could be preferable than a

biennial survey. This point, of course, holds only if the sardine population does not collapse: in this case of a collapse, a biennial survey for controlling the situation would be sufficient.

Sardines are also more superficial in nature than are hakes, swimming in dense schools that have the ability to avoid vessels. In order to compensate these problems, the SW team has developed important research on multibeam sonars, which are able to observe outside of the vessel path and in the surface layers. So far the results of the works showed that the biases induced by school behavior were not significant; nevertheless it is clear that multibeam sonar is a way to better monitor the pelagic ecosystem. This kind of instruments is less necessary for hake. Nonetheless, I recommend that research be undertaken in this area during the SaKe surveys.

International co-operation between Canada and USA for surveying the sardine populations are not so clearly defined as in the case of hake. Every other year the survey of Canadian waters was performed by the US vessels. Also, until 2013 no co-operation between Mexico and USA existed for surveying the sardine populations. This will change as Mexico operates now a large R/V equipped with modern acoustic devices and counts with a well trained team (CICIMAR, La Paz, Baja California) who will co-operate in this field. The opportunity should be taken to develop a full international survey of the California Current coastline in an EAF approach including Canada, USA and Mexico: such joint surveys would provide unique information and data bases for the understanding of EBOEs.

6) Evaluate the tradeoffs, in terms of costs, benefits, and consequences, of:

a. separate hake and sardine surveys every year or every other year, with or without ecosystem sampling

b. joint sardine and hake surveys every year or every other year, with or without ecosystem sampling,

Alternative joint survey options for hake or sardine every year or every other year, with or without ecosystem sampling, particularly regarding their potentials to: i) estimate population parameters for hake, sardine, and other forage species; ii) put that information into the context of their biotic and abiotic environments; and iii) characterize their roles in the California Current Ecosystem. Provide specific recommendations for short- and long-term improvements to anticipate compromises associated with sardine-hake-ecosystem surveys.

Most of the comments on these points have been made previously. I have synthesized all the costs, benefits and inconvenience of each of the possibilities in a table below. I identified six different possible strategies:

- Separate hake and sardine survey each year: this is already the case for sardine.
- Separate hake and sardine survey each other year: this is already the case for hake.
- Alternative joint survey for hake or sardine: this is one option for the SaKe surveys; in this case there is a SaKe survey each year, but during years 1, 3, etc. the effort is mostly dedicated to sardine, with a less intense activity on hake. In this case the sardine survey provides a precise abundance estimate and biological characteristics description while the information on hake is mostly collected in order to check if the

stock is not suffering unexpected changes. During years 2, 4, etc. the priorities are reveresed and the surveys are focused on hake with a less intensive effort on sardine.

- Joint sardine and hake survey each year: another possibility for SaKe surveys, where the effort is the same every year for the two groups of species. This is similar to option 1 but with the two teams working together during the same survey.
- Joint sardine and hake each other year: another possibility for SaKe surveys with the same option as above but only every other year.
- Joint sardine and hake survey each year and research survey each other year: another possibility for SaKe surveys. In this case, in the first year two R/V perform jointly the hake and sardine survey (intensive sampling), and in the second year, one R/V performs the survey and the second R/V simultaneously performs a research survey.

Table 1. Cost, advantage and inconvenient of the different possible survey strategies.
A+ or A-: estimate population parameters for hake, sardine, and other forage species
B+ or B-: put that information into the context of their biotic and abiotic environments
C+ or C-: characterize their roles in the California Current Ecosystem
D+ or D-: allow research to be performed in key questions

Survey strategy	Cost	Advantage	Inconvenience
Separate hake and sardine survey each year **A+ B- C- D-**	2 surveys each year. 2 R/V each year 2 sets of equipment	Simple (continuation of the existing) with accurate results for the two groups of species	No EAF, duplicate of effort, no shared equipment and experiences
Separate hake and sardine survey each other year **A- B- C- D+**	1 survey each year. 1 R/V each year 1 set of equipment	Same as above Possibility of research for the other team during the other year (if 2 R/V available)	No data each other year for the two species. No EAF
Alternative joint survey for hake or sardine **A+ B+ C- D+**	1 survey each year 1 R/V each year 1 set of equipment	Rather simple; accurate information for one group on one year, and indicators on the other year	No real integration of the teams; no time for research (time and vessel availability)
Joint sardine and hake survey each year **A+ B+ C+ D-**	1 survey each year 1 R/V each year 1 set of equipment	EAF possible. Information shared by the teams. Accurate information on the two groups each year	Complex: requires making compatible different priorities. Difficulty for research (time and vessel availability)
Joint sardine and hake each other year **A-B+C+D+**	1 survey each other years 1 R/V each other year	EAF possible; low cost; accurate information on the two groups each other year	No information each other year; same complexity as above
Joint sardine and hake survey with 2 vessels one year and assessment	2 surveys each year 2 sets of equipment 2 R/V each year	EAF; research on different points of the method and the ecosystem; accurate information each year;	Complex; high cost; requires 2 R/V each year

survey + research survey the other year **A+B+C+D+**		information shared by the teams; resolves the problems of compatibility	

7) Evaluate proposals and provide recommendations to increase the efficacies and efficiencies (e.g., through advanced technologies) of sardine, hake, sardine-hake and sardine-hake-ecosystem surveys, based on SaKe 2012 and 2013 survey experiences.

The proposal of transforming the separate summer hake and sardine surveys into a single summer SaKe survey presents a great number of advantages compared to continuing performing separate surveys, in the many ways that I listed in my report. It is clear that the most important advantage is the move towards an EAF concept The results of assessments of the two groups of species show clearly that an important part of the variability in the dynamics of the stocks, and especially the recruitment, is linked to variation of the ecosystem; in the two cases the relationships between the recruitment and the El Niño Southern Oscillation (ENSO) was noted, as well as the relationships of hake distribution with currents, and of sardine with temperature. The effect of warm or cold decadal periods is also obvious, and explains why the sardine team is expecting a collapse of the stock in the coming years and an increase in the anchovy population. Therefore no real understanding (and consequently predictive capability of the models) can be expected without information on the pelagic ecosystem.

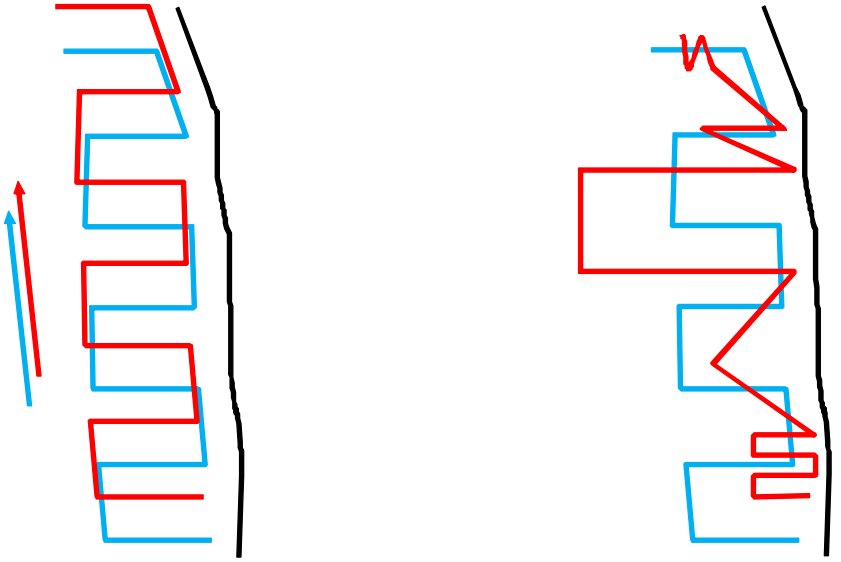
This enormous advantage of SaKe surveys implies some points in the methodology of the two teams can be adapted. The two separate surveys have been fitted to the particular characteristics of the populations surveyed (e.g. acoustic and biological sampling strategies), which do not coincide with those of the other population; some compromises must be found, but the general characteristics of the two stocks have been proved to be generally compatible, as observed in 2012 and 2013. In a large part the "methodological conflicts" are more due to different habits of the teams than to real incompatibilities.

Another point must be stressed. It has been stated several times by the two teams (but mostly by the hake team) that incomplete information (e.g. not including the Canadian part of the stock) could not be used by the assessment models. Although assessment is not my domain of expertise I am extremely doubtful on this point. Having information on half of the distribution area provides a series of indicators that allow assuming whether the stock dynamics are in conformity with the prevision of the models or not. I am convinced that the results of acoustic surveys are not fully exploited from this point of view and that annual survey, even though the Canadian waters are not explored, would give valuable information for the stock assessment programs. Another point is that it is quite likely that at least for hake an intertransect distance of 20 NM would not give different results from a survey with a 10 NM intertransect distance. The sampling effort of the NW team is high and could be reduced, for instance, in order to increase the biological sampling or the ecosystem observations.

3. GENERAL RECOMMENDATIONS

SaKe should be approved and implemented. In this case, and despite its higher cost, the last possibility listed in Table 1 is by far the best approach. Actually it is only possible if two research vessels are available each year for this program. It seems that this will be the case in the near future (2014 or 2015), according to information provided by NOAA.

The experience on hake and the expected risk of collapse of sardine show that lacking of information each other year could be an issue. It seems essential to get annual information, although there is no real need to get very accurate information every other year. Then very accurate information on years 1, 3, 5… plus a general overview on years 2, 4, 6… seems the best compromise in order to be able to dedicate some time for research. Indeed some points in the methodology as well as some biological and ecological issues remain questionable and must be documented. I recommend the following sampling strategy (Figure 1).



Survey design years 1, 3, 5…
Coastline in black; R/V 1 in blue and R/V 2 in red; inter-transect distance (between blue and red transects): 10 nautical miles; such design allows precise information on distribution and abundance estimates for the two groups of species

Survey design years 2, 4, 6…
Coastline in black; R/V 1 in blue and R/V 2 in red; inter-transect distance for survey vessel (blue transects): 20 nautical miles; research survey (red) can take any design that a research question can require (e.g. detailed observation along the coastline; long transects offshore; experimental observations with non conventional acoustic devices; etc.) for improving the survey design and methods.

Figure 1: Survey design with two R/V, depending on the year

Left: years 1, 3, 5… correspond to high precision surveys on sardine and hake with intertransect distance 10 NM.
Right: years 2, 4, 6… correspond low precision surveys of sardine and hake performed by one R/V with intertransect distance 20 NM, plus research activities with the other R/V with transects and route depending on the researches needed for improving the survey methodology, adapting new acoustic devices, observing more in details other populations (e.g. anchovy on the shore or jack mackerel offshore), performing EAF observations, etc.

Year 1, 3, 5… Years of the accurate survey. During these years the two R/Vs sail together in parallel following the schema displayed in Figure 1, allowing for accurate estimates of biomass

for the two groups of species. Besides, the interlaced schema allow for some statistical research on the need of low intertransect distance, on the effect of R/V on avoidance, intercalibrations of the vessels, comparison of different acoustic devices (keeping in mind that the standard frequencies of vertical echo sounders must work aboard the two vessels) such as multibeam sonar or any other devices, etc. It could also allow dedicating each vessel to a given group of species for biological sampling, in case this could reduce the time wasted in changing the gear, etc.

Years 2, 4, 6… Years of the research activities. This should be for the years with no common survey with Canada. One of the two R/V performs the same survey design as in years 1, 3, 5… that provides a relatively good information on the structure of the population during this year to the assessment experts. The precision is lower than in the other years but it seems clear that a 20 NM intertransect distance would give results practically identical to those of the years with 10 NM distances (this can be easily tested by some statistical work on the existing surveys) for hake, maybe not so accurate for sardine. In counterpart, the availability of the second R/V for performing research will give several important sets of information: some time could be dedicated to fish species that are not completely inside the general survey area, e.g. anchovies very close to the shore in highly concentrated small areas, or jack mackerel that can be observed far from the coast; results on the use (and applicability) of non conventional acoustic devices; experiments and routes allowing statistical measurement on the precision of the acoustic data (measurement of avoidance, effect of highly asymmetric distribution of the abundance, anisotropy of the distributions, characteristics of schools and clusters of schools, measurement of migrations, etc.); characterization of the ecosystem (survey on krill and micronekton, specific biological sampling, etc); characterization of the 3D structure of the water masses; characterization of the potential habitat for the targeted species; co-operation with the teams from Canada or Mexico (intercalibrations, etc.).

Such survey design could be applied during 5 years, as suggested by the two Centers, and an evaluation done after this delay in order to produce a final decision of the SaKe methodology.

François Gerlotto

Montpellier, 6 February, 2014

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Appendix 2. Statement of Work

External Independent Peer Review by the Center for Independent Experts

Review of Pacific sardine and Pacific hake joint acoustic-trawl survey

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The CIE reviewers will serve on a methodology review panel to perform an independent peer review of the Pacific sardine and Pacific hake joint acoustic-trawl survey conducted by the NMFS's Southwest Fisheries Science Center (SWFSC) and Northwest Fisheries Science Center (NWFSC). In 2012, a newly integrated acoustic-trawl survey of both Pacific Hake and Pacific sardine was implemented in waters off the US and Canada. This effort was the result of a unique collaboration and partnership between SWFSC and NWFSC fishery scientists, as well as Canada's Department of Fisheries and Oceans (DFO) and the fishing industry. The survey's primary goal was to measure the distributions and abundances of Pacific hake and Pacific sardine. In addition, oceanographic and environmental data were sampled to estimate the physical oceanographic habitats for each target species. Results of this survey were used in the 2013 assessment of the Pacific hake stock in US and Canadian waters. A review of the joint acoustic-trawl survey of Pacific hake and Pacific sardine will be conducted to review the survey methodology and analytical approaches to estimate abundance, distribution and biomass of Pacific hake and Pacific sardine resources.

Requirements for CIE Reviewer:

Four CIE experts, three independent reviewers and one panel Chair, shall participate in a panel peer review in accordance with the SoW and ToRs herein. The three CIE reviewers shall have the combined expertise and working knowledge in acoustic-trawl survey design, operation, sampling and analysis; ecosystem survey design, operation, sampling and analysis; spatial sampling and analysis with experience in geo-statistics; and familiarity with groundfish and/or coastal pelagic species with annual migration. At least one reviewer shall have working knowledge and expertise in the application of acoustic fish surveys in stock assessments. Experience (and/or familiarity) with acoustic sampling for mid-water, bottom and pelagic

species is desirable. In addition to the three CIE reviewers, one CIE expert will serve as Panel Chair. The Panel Chair shall have excellent facilitation and communication skills and expertise in acoustic-trawl surveys and/or one of the areas of expertise outlined above. The primary role of the Panel Chair will be to facilitate an impartial review panel and provide a summary report of the panel proceedings. The Panel Chair may also actively participate in panel discussion and provide feedback during the panel meeting. The CIE reviewer's duties shall not exceed a maximum of 16 days to complete all work tasks of the peer review process. The Panel Chair's duties shall not exceed a maximum of 18 days to complete all work tasks of the facilitation and summary report process. The agenda for the Panel review meeting will be provided to reviewers along with background materials two weeks prior to the panel meeting.

Location/Date of Peer Review: Four CIE experts, one of which will serve as the Panel Chair, shall participate during a panel review meeting in Seattle, Washington to be held January 21-24, 2014.

Statement of Tasks: Each CIE expert shall complete the following tasks in accordance with the SoW, ToRs and Schedule of Milestones and Deliverables specified herein.

Prior to the Peer Review: Upon completion of the CIE expert selection by the CIE Steering committee, the CIE shall provide the CIE expert information (name, affiliation, and contact details) to the COR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to each CIE expert. The NMFS Project Contact is responsible for providing the CIE experts with the background documents, reports, foreign national security clearance, and information concerning other pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE experts participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE experts who are non-US citizens. For this reason, the CIE experts shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website:

http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send by electronic mail or make available at an FTP site to each CIE expert all necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE on where to send documents. Pre-review documents will be provided up to two weeks before the peer

review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, the CIE experts are responsible only for the pre-review documents that are delivered to them in accordance to the SoW scheduled deadlines specified herein.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs. **Modifications to the SoW and ToR cannot be made during the peer review, and any SoW or ToR modification prior to the peer review shall be approved by the COR and CIE Lead Coordinator.** Each CIE expert shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their tasks shall be focused on the ToRs as specified in the contract SoW.

The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2. The CIE expert serving as Panel Chair shall complete a summary report of the panel proceedings including a summary of the individual reviewers' major findings and recommendations. The summary report shall not be a consensus report.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review;
2) Participate during the panel review meeting in Seattle, Washington during 21-24 January 2014, and conduct an independent peer review in accordance with the ToRs (Annex 2);
3) No later than February 7, 2014, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and Dr. David Die., CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. The CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2.
4) Work with the CIE Chair in providing comments and elaboration on any points raised in the CIE Chair's summary report that might require further clarification.

Specific Tasks for CIE Chair: The following chronological list of tasks shall be completed in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review;
2) Participate as the CIE Chair during the panel review meeting in Seattle, Washington during 21-24 January 2014, and facilitate the panel review maintaining the focus of the peer review in accordance with the ToRs (Annex 2);
3) Produce a Summary Report of the proceedings. The summary report shall not comprise a consensus report and will instead include a synoposis of each term of reference as per the chair's summary of each reviewer's determination. The CIE reviewers should have an opportunity to review and provide comments or elaboration on any points raised in the summary report that they feel might require further clarification. No later than February 21, 2014, the CIE Chair shall submit a Summary Report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and Dr. David Die., CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. The Summary Report shall address each ToR in Annex 2.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

17 December 2013	CIE sends the experts' contact information to the COR, who then sends this to the NMFS Project Contact
07 January 2014	NMFS Project Contact sends each CIE reviewer and the CIE Chair the pre-review documents
21-24 January, 2014	The CIE reviewers participate and conduct an independent peer review during the panel review meeting. The CIE Chair facilitates the impartial peer review and participates in panel discussion.
07 February 2014	Each CIE reviewer submits a draft CIE independent peer review report to the CIE Lead Coordinator and CIE Regional Coordinator. These reports will be forwarded to the CIE Chair by the CIE Lead Coordinator
14 February 2014	The CIE Chair submits the working Summary Report to the CIE reviewers
17 February 2014	The CIE reviewers provide their comments and elaborate on any points raised in the summary report that require additional explanation to the CIE Chair
21 February 2014	The CIE Chair submits the draft Summary Report to the CIE Lead Coordinator and CIE Regional Coordinator
28 February 2014	CIE submits the CIE independent peer review reports and CIE Chair's Summary Report to the COR
6 March 2014	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Directors

Modifications to the Statement of Work: Requests to modify this SoW must be made through the Contracting Officer's Technical Representative (COR) who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE experts to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports and summary report by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards: (1) the CIE reports shall have the format and content in accordance with Annex 1, (2) the CIE reports shall address each ToR as specified in Annex 2, (3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon notification of acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the approved CIE reports to the NMFS Project Contact and regional Center Director.

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. Each CIE independent peer review report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations.

2. The main body of each peer review report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe using their own words, the review activities completed during the panel review meeting, including a detailed summary of findings, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. Each CIE independent peer review report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not they read the summary report. Each CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. Each report shall include the appendices as follows:

   Appendix 1: Bibliography of materials provided for review

   Appendix 2: A copy of the CIE Statement of Work

   Appendix 3: Panel Membership and other pertinent information from the panel review meeting.

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Annex 2: Terms of Reference (ToR) for the Center for Independent Experts Panel Review of the Joint Pacific Sardine and Pacific hake (SaKe) acoustic-trawl survey

The CIE Chair shall facilitate the panel review on the ToR, and each CIE reviewer shall conduct an independent peer review addressing each ToR;

1) Review background materials and documents that detail acoustic-trawl survey design and methods, and data analysis methods and results for:
    a. Pacific sardine surveys;
    b. Pacific hake survey;
    c. Joint sardine and hake (SaKe) surveys.
2) Evaluate the historic, independent sardine and hake survey designs, methods, and analytical approaches including data preparations and statistical (e.g. geostatistical) analyses to estimate target species abundances, distributions, and biomasses, and associated uncertainties.
3) Evaluate the current joint SaKe survey design, methods, and analytical approaches including data preparations and statistical (e.g. geostatistical) analyses to estimate target species abundances, distributions, and biomasses, and associated uncertainties.
4) Evaluate the tradeoffs, in terms of costs, benefits, and consequences, of transitioning from independent surveys to a joint sardine-hake survey, particularly regarding its potential to provide population trend information to each of the assessments.
5) Evaluate the potential of the SaKe survey design and analysis, or an alternative, to evaluate the status and trends of hake, as managed by the International Hake Treaty, the southern stock of sardine, and other stocks in the Pacific Fisheries Management Council's Coastal Pelagic Fisheries Management Plan (CPS-FMP) including: northern anchovy (northern and central stocks), Pacific mackerel, jack mackerel, market squid, and krill.
6) Evaluate the tradeoffs, in terms of costs, benefits, and consequences, of:
    a. separate hake and sardine surveys every year or every other year, with or without ecosystem sampling
    b. joint sardine and hake surveys every year or every other year, with or without ecosystem sampling,
    c. Alternative joint survey options for hake or sardine every year or every other year, with or without ecosystem sampling,

    particularly regarding their potentials to: i) estimate population parameters for hake, sardine, and other forage species; ii) put that information into the context of their biotic and abiotic environments; and iii) characterize their roles in the California Current Ecosystem. Provide specific recommendations for short- and long-term improvements to anticipated compromises associated with sardine-hake-ecosystem surveys.

7) Evaluate proposals and provide recommendations to increase the efficacies and efficiencies (e.g., through advanced technologies) of sardine, hake, sardine-hake and sardine-hake-ecosystem surveys, based on Sake 2012 and 2013 survey experiences.

Agenda
The Center for Independent Experts Panel Review of
the Joint Pacific Sardine and Pacific hake (SaKe) acoustic-trawl survey

NOAA Western Regional Center
7600 SandPoint Way NE, Building 1
Workforce Management Conference Room
Seattle, Washington 98115
January 21-24, 2014

Tuesday, January 21, 2014

8:30 a.m. Welcome, Purpose, and Introductions (Michelle McClure and Russ Vetter)
8:45 a.m. Review Meeting Agenda, Terms of Reference and Assignment of Rapporteur Responsibilities (Panel Chair)

Agenda Item A. Introduction and Background: Species Biology and Surveys

9:00 a.m. i. Biology of Pacific sardine (Russ Vetter)
ii. Biology of Pacific hake (Michelle McClure)
iii. Brief history of the collaborative SWFSC-NWFSC surveys (Michelle McClure)
iv. Focus of this review (Russ Vetter)

10:30 a.m. Coffee Break

Agenda Item B: Historical Individual Surveys

10:45 a.m. History of acoustic-trawl surveys of Pacific sardine (David Demer)
11: 30 a.m. Q & A
12:30 p.m. Lunch
1:30 p.m. History of acoustic-trawl surveys of Pacific hake (Larry Hufnagle)
2:30 p.m Q & A
3:30 p.m. Coffee Break
4:00 p.m. Public Comment
4:15 p.m. Panel Discussion
5:30 p.m. Panel Adjourns for the Day

Wednesday, January 22, 2014

8:30 a.m. Welcome and Schedule Overview

Topic C. Joint SaKe Survey (Strengths and Challenges of Current Solution)

8:45 a.m. Development of Collaborative Sardine and Hake Surveys (SaKe) : Personnel, Equipment, Ships, Transects, and Acoustic, Biological, and Ecological Sampling (David Demer and Larry Hufnagle)
9:45 a.m. Q & A

Wednesday, January 22, 2014 (Continued)

10:30 a.m. Coffee Break
10:45 a.m. Strengths and Challenges of Jointly Conducting the Survey -- Sardine (David Demer)
11:30 a.m. Q & A
12:30 p.m. Lunch
1:30 p.m. Strengths and Challenges of Jointly Conducting the Survey -- Hake (Larry Hufnagle)
2:30 p.m. Q & A
3:30 p.m. Coffee Break
4:00 p.m. Public Comment
4:15 p.m. Panel Discussion / Report Drafting
5:30 p.m. Panel Adjourns for the Day

Thursday, January 23, 2014

8:30 a.m. Welcome, Schedule Overview, and Review of Primary Questions

Topic D. Evaluation of Trade Offs (Strengths and Challenges of Proposed Future Solutions)

8:45 a.m. Proposals for Annual or Biennial, Single- or Multi-Species Surveys with or without Ecological Sampling (Russ Vetter and Michelle McClure)

9:45 a.m. Q & A
10:30 a.m. Coffee Break
12:30 p.m. Lunch
1:30 p.m. Panel Discussion
3:30 p.m. Coffee Break
4:00 p.m. Public Comment
4:15 p.m. Panel Discussion / Report Drafting
5:30 p.m. Panel Adjourns for the Day

Friday, January 24, 2014

8:30 a.m. Welcome and Overview of the Day
8:45 a.m. Report Drafting
12:30 p.m. Lunch
1:30 p.m. Report Out by Reviewers
2:00 p.m. NWFSC and SWFSC Leadership Wrap Up with Panel (Closed Session)
3:00 p.m. Panel Adjourns

Appendix 3: Panel Membership and other pertinent information from the panel review meeting

CIE Review Panel

Dr. Gary Melvin, Center for Independent Experts (CIE), Panel Chair
Dr. François Gerlotto, Center for Independent Experts (CIE)
Dr. George Rose, Center for Independent Experts (CIE)
Dr. Jon Helge Vølstad, Center for Independent Experts (CIE)

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